Please replace the paragraph beginning on page 1, line 24, with the following rewritten paragraph:

A2 In such cases, instead of performing an inspection of individual building boards at each manufacturing process thereof, an inspection process is usually performed at the final stage of manufacturing process so as to perform the inspection on the finally finished product. The building board that has passed through this inspection is then usually marked with a specific manufacturer's serial number so as to make it possible to distinguish each building board by this serial number. The reason for performing the inspection at the final stage of manufacturing process may be attributed to the fact that it is very difficult to uniformly impose inspection conditions at a point midway through the manufacturing process. For example, the object of inspection may not be moving along a fixed location of transferring line, or the object of inspection just transferred from a drying process may inevitably undergo a physical or chemical change due to a thermal change with time. Namely, the fact that the object of inspection is not necessarily in a stable state at the midway point of the manufacturing process is one reason for not performing the inspection at the midway point.

Please replace the paragraph beginning on page 3, line 21, with the following rewritten paragraph:

A3 The present invention has been made to solve the aforementioned problems. Therefore, an object of the present invention is to provide an inspection system which enables even in the production process even at remote locations and allows one to trace and inspect how large the external appearance of a great number of work boards, that have been placed on a continuous work line, will be changed after undergoing each manufacturing process.

Please replace the paragraph beginning on page 3, line 28, with the following rewritten paragraph:

A4 Another object of the present invention is to provide an inspection system which is capable of identifying each individual work board and of recording the manufacturing conditions of the individual work board even if the external appearance of that work board is liable to change in the manufacturing process along a continuous work line.

Serial No. 09/578,038
Docket No. HIAS.95176

101461v1

Please replace the paragraph beginning on page 4, line 6, with the following rewritten paragraph:

A5 Namely, according to the present invention, there is provided an inspection system, which comprises a line sensor for one-dimensionally imaging an elongated work boards, a velocity-measuring means for measuring a moving velocity of the work board, a sampling control means for controlling the sampling of said line sensor on the basis of the moving velocity of the work board to be measured by said velocity-measuring means, and an image-composing memory for composing an output of said line sensor to generate a two-dimensional image data.

Please replace the paragraph beginning on page 4, line 19, with the following rewritten paragraph:

A6 The inspection system may be further provided with a controlling means to correct the sampled image data based on the extent to which the work board is slanted or moved out of a normal position, thereby making it possible to easily compare the image data with that of image data of a standard work board or other work board.

Please replace the paragraph beginning on page 4, line 24, with the following rewritten paragraph:

A7 Further, the inspection system may be further provided with a data transmitting means for assigning a transmission channel to every work board and assembling the image data into data-packets so as to transmit them, thereby making it possible to effectively transmit the image data without causing a collision between many packets of data.

Please replace the paragraph beginning on page 6, line 22, with the following rewritten paragraph:

A8 Fig. 7C is a diagram illustrating a method of calculating the angle of deviation;

Please replace the paragraph beginning on page 6, line 24, with the following rewritten paragraph:

A9 FIG. 8A is a X-Y coordinates of a work board;

Please replace the paragraph beginning on page 7, line 27, with the following rewritten paragraph:

FIG. 1 is a top view illustrating automatically a part of the continuous work line which can be suitably applied to the inspecting system of work board according to one embodiment of the present invention. In the following explanation, a building board 1 is exemplified as the work board. A raw board 1 of the building board goes at first into a manufacturing process (1) in the direction of an arrow Al. After finishing a working in the manufacturing process (1), the work board is inspected at an inspection process (1) and then, moved to the next manufacturing process (2). After finishing treatment in the manufacturing process (2), the work board is inspected at an inspection process (2) and then, changes the moving direction to move the next manufacturing process (3). After finishing ~~a~~ working in the manufacturing process (3), the work board is inspected at an inspection process (3) and then, further turned and delivered in the direction of an arrow A3 for subjecting it to the next manufacturing process.

A10

Please replace the paragraphs beginning on page 8, line 16 through page 11, line 28 with the following rewritten paragraphs:

A great number of work boards 1 are intermittently fed at predetermined intervals into the continuous working line in this manner. After finishing a predetermined number of treatment processes, the work boards ultimately exit the continuous working line. During these working processes, the work boards are moving individually through the continuous transferring line.

A11

There is an upper limit with respect to the total number of work boards that can be placed on the transferring line as the transferring lines are steadily operated.

On the other hand, as far as each manufacturing process is concerned, the time when the work board 1 goes into or enters the prescribed manufacturing process as well as the time when the same work board 1 goes out from or exits said prescribed manufacturing process can be represented by an absolute value of time of working (it means that the time elapsing minute by minute would never go back) which is applied to individual work board 1 in said prescribed manufacturing process. The work board 1 may enter and exit the manufacturing process at the same moment in other manufacturing processes. However, as far as a single specific manufacturing process is concerned, the time when the individual work board enters and exits the manufacturing process is a value peculiar to this individual work board 1. This will be specifically explained below.

For example, assuming that the work line is operated in a steady state, when a work board 1 enters at 10:00 in the manufacturing process 1 and then, exits from the manufacturing process 1 at 10:10 as scheduled, this 10 minutes of working during which this work board 1 has been treated in the manufacturing process 1 can be represented by three data (process number = it 1; entry time = 10:00; and exit time = 10:10) . From these data, it can be shown that this work board 1 lies in the manufacturing process 1 for receiving a treatment during this period of time.

Supposing that this work board 1 exits at 10:15, there is a possibility that trouble of some kind may have occurred in this or other manufacturing process. Specifically, when this work line is temporarily suspended, due to some problem that has occurred in this manufacturing process, or in another manufacturing process, a delay would be caused in the exit time. Therefore, it is impossible to determine if the work board 1 to be inspected has been really worked in a steady state, knowing only the exit time.

FIG. 2 is an enlarged schematic view illustrating a main portion of the continuous work line shown in Fig. 1. When the detecting light emitted from a photoelectric switch SW1 is intercepted by the leading end portion of work board 1 as the work board 1 is moved in the direction of a

n arrow A, the photoelectric switch I detects that the work board 1 goes into or enters a manufacturing process (n). When the light emitted from a photoelectric switch SW1 is not intercepted by the trailing end portion of work board 1, the photoelectric switch SW1 detects that the work board 1 going into the manufacturing process (n) has ended and an exit finish time tie (n) is measured and a scheduled exit starting time tees (n) is calculated. When the detecting light emitted from a photoelectric switch SW2 is intercepted by the leading end portion of work board 1, the photoelectric switch SW2 detects that the work board 1 exiting the manufacturing process (n) is started, and an exit starting time tes (n) is measured so as to compare it with the scheduled exit starting time tees (n), thereby checking that the work board 1 has exited. When the detecting light emitted from a photoelectric switch SW2 is not intercepted by the trailing end portion of work board 1, the switch SW2 detects that the work board 1 exiting the manufacturing process (n) has ended and the exit finish time tee (n) is measured and a scheduled entering-starting time teis (n+1) to the next manufacturing process (n+1) is calculated. When the detecting light emitted from a photoelectric switch SW3 is intercepted by the leading end portion of work board 1 after the work board 1 has passed through an inspection process (n) of the manufacturing

process (n), the photoelectric switch SW 3 detects that the work board 1 going into the manufacturing process (n+1) is started, and a going-into-or entering starting time tis (n+1) is measured so as to compare it with the scheduled entry starting time teis (n+1), thereby checking that the work board 1 has entered.

When the entering time is measured and the work board 1 has exited at a scheduled exit starting time in this manner, an inspection or an acquisition of image data is performed. Thereafter, when the work board 1 is moved into the next manufacturing process at a scheduled time after finishing the inspection in the previous process, it is determined that the work board 1 is ready to receive the next treatment.

A11

As explained above, the measurement of the entry time of the work board 1, the measurement of the exit time of the work board 1, the determination of whether the work board 1 has actually left the manufacturing process at a scheduled exit time measurement based on the entry time, the execution of inspection following the manufacturing process, and the determination of whether the work board 1 has actually entered the next manufacturing process at a scheduled entry time measurement based on the unloading time are all designed to be executed by "the manufacturing process controller" for controlling this manufacturing process.

Since the scheduled exit time and the scheduled entry time for the next manufacturing process are all calculated estimated values, some degree of tolerance should be allowed in the determination of the actual time in view of possibility of generating a slight degree of error in moving time of the work board 1 due to various factors such as a slippage of a transferring means.

Please replace the paragraph beginning on page 12, line 28, with the following rewritten paragraph:

A12

FIG. 3 is a schematic view illustrating the arrangement of the inspecting process portion. The manufacturing process controller 100 (to be explained in detail with reference to FIG. 10) is designed to identify each work board 1 on the basis of the time obtained respectively from the photoelectric switch SW1 (for measuring the entry time of the previous manufacturing process), the photoelectric switch SW2 (for measuring the exit time of the previous manufacturing process), and the photoelectric switch SW3 (for measuring the entry time of the next manufacturing process). The work board 1, transferred from the previous manufacturing process

by means of the transferring rollers 31, is detected by a photoelectric switch SW4, and then, the transferring velocity thereof is detected by a rotary pulse encoder 13. Based on this transferring velocity, the sampling rate is determined, and the surface of the work board **1** is one-dimensionally imaged by means of a CCD line sensor camera 11. The image data obtained by this imaging is accumulated occasionally in a hard disk HDD 16. As a result, even if the work board 1 is moving at a varying speed, it is possible to determine the sampling timing of image data on the basis of output obtained through the measurement by the rotary pulse encoder 13 attached to the transferring roller 31 for measuring the rotational velocity of the transferring roller 13 which is installed immediately below or immediately in front of the CCD line sensor camera 11 positioned over the transferring zone of the work board 1.

A12

Please replace the paragraph beginning on page 13, line 28, with the following rewritten paragraph:

FIG. 4A is a block diagram illustrating an internal configuration of the CCD line sensor camera 11 shown in Fig. 3. This CCD line sensor camera 11 is provided with two systems for reading, i.e. a system (1) for an odd number line and a system (2) for an even number line, thereby enabling it to enhance the resolution. The imaged data is fed from each reader to an analog-digital converter 34 (A/D(1), and 44 A/D(2)), respectively, in which they are converted into digital form. As shown in FIG. 4B, the measuring point (1) and the measuring point (2) are positioned away from each other along the transferring or movement direction of the work board 1, thus in the transferring direction A. These measuring points (1) and (2) are given to be imaged by an optical system (1) 31 and an optical system (2) 41, respectively. The results thus imaged are then photo-electrically converted by means of a line photosensor (1) 33 and a line photosensor (2) 43 which are to be driven using a CCD driving circuit (1) 32 and a CCD driving circuit (2) 42, respectively, as shown in FIG. 4A. The analog signals thus obtained through this photo-electric conversion are then converted into digital signals. Then, the RGB data of the odd number line is temporarily stored in a line image memory (1) 35, while the RGB data of the even number line is temporarily stored in a line image memory (2) 45, thereby enabling them to be transmitted to an image compressing memory 12 of the manufacturing process controller 100.

A13

Please replace the paragraph beginning on page 15, line 10, with the following rewritten paragraph:

FIG. 5 is a diagram illustrating changes of line reading rate. When the moving velocity of the work board 1 is assumed to be 1m/sec., at the initial moment (1), the reading of data-sampling points 1 and 2 is performed, respectively, at the measuring point (1) of the odd number line as well as at the measuring point (2) of the even number line. At the next moment (2) 5 msec after the initial moment (1), the reading of the data-sampling points 3 and 4 is performed respectively at the measuring point (1) as well as at the measuring point (2). Further, at the next moment (3) 5 seconds after the aforementioned moment (2), the reading of the data-sampling points 5 and 6 is performed respectively at the measuring point (1) as well as at the measuring point (2). Whereas, when the moving velocity of the work board 1 is accelerated faster than 1m/sec., the work board 1 is caused to move a longer distance during this 5 seconds, so that the line reading pulse is required to be shifted so as to increase the sampling rate in order to make it possible to read with the same resolution as the previous moving velocity at the moment of (2) '.

A14

Please replace the paragraph beginning on page 15, line 28, with the following rewritten paragraph:

FIG. 6 is a diagram illustrating the accumulation of image data in an image-composing memory 12 (see Fig. 10). In this embodiment, only a R (red) signal is illustrated. However, this can be also applied to a G (green) signal as well as a B (blue) signal. Each line image memory 35 or 45 (see FIG. 4) is constituted on the FIFO (first-in first-out) basis and hence, the data can be read out according to the line-reading pulse and written in compression in the image-composing memory 12 of the manufacturing process controller 100. In this case, the odd number line data of row number nn, i.e. Lo1, Lo2, Lo3, ---, Lonn and the even number line data of row number nn, i.e. Le1, Le2, Le3, ---, Lenn are simultaneously and alternately written while changing the row in the memory 12. In this case, not only the board image data but also the background image data are simultaneously written in the memory 12. However, this problem can be corrected in a subsequent data processing. In this manner, a board image to be inspected can be composed.

A15

Please replace the paragraphs beginning on page 17, lines 2 through line 17, with the following rewritten paragraphs:

A16

Based on the angle of slant θ thus obtained, the affine transformation is performed so as to obtain image data where the slant is corrected.

FIG. 8A is an X-Y coordinate representation of a work board. When the position (X, Y) is rotated by an angle of θ as the work board 1 is deviated by an angle of θ as shown in FIG. 8B so as to obtain the position (x, y) as shown in FIG. 8A. the following equations can be obtained.

$$x = X \cos \theta + y \sin \theta$$

$$y = -X \sin \theta + Y \cos \theta$$

In this manner, the sampling of board image data on an elongated board which is a moving object to be inspected can be performed accurately in a non-contact manner and at a high speed, and at the same time, when the image data obtained is compared with a standard board image data that has been recorded in advance . This offers easy detection whether or not the occurrence of abnormality has occurred.

Please replace the paragraphs beginning on page 17, line 23 through page 19, line 19, with the following rewritten paragraphs:

FIG. 9 is a diagram illustrating a relationship between the image data of a composed board (already corrected) and image data to be displayed. The aforementioned composed board image data is then subjected to data processing for enabling it to be transmitted to a production controller located at a remote place. Namely, the data compression is performed in order to reduce the aforementioned composed board image data to an image size suited for displaying it as a board image in a monitor display 71 (see FIG. 17) which is connected with the production controller. In this case, it is instructed by the production controller that "in what degree of resolution the image should be displayed ?", so that the resolution of monitor itself to be actually displayed is taken into account. While the composed board image data is of high resolution for the purpose of inspection, the display image data is of standard resolution. If the composed board image data is; the number of pixel: md x nd; actual size: Md x Nd, while a monitor display 50 is; the number of pixel: xd x yd; corresponding actual display size: Xd x Yd, and if the display reduction ratio β , the actual display size becomes Md x β x Nd x β, and the image data is compressed in such a manner that md pixel and nd pixel become;

(Md x β) x (xd/Xd) and

(Nd x β) x (yd/Yd) , respectively.

FIG. 10 is a block diagram illustrating the constructions of the manufacturing process controller 100 and those of the production controller according to this embodiment. Detailed

operation of these controllers will be explained in the flow chart shown in FIG. 11. The local main controlling section 101 provided with a communication control section 27 is designed to control entirely individual control module. The board specifying section 4 is designed to identify the individual work board 1 by the use of the photoelectric switches SW1 to SW3 and the timers 3 (timers (1) & (2)), the result being stored in the memory 5. With respect to the work board 1 thus specified, an abnormal moving thereof is judged by an abnormality determining section 7 by the use of a timer 6 (timer (3)) also, the result being stored in a flag register 7a. The sampling control section 10 is designed to control the sampling of the CCD line sensor camera 11 by the use of the photoelectric switches SW4, the timer 9 (i.e., (4)) and the sampling rate corrected, on the basis of the pulse from the rotary pulse encoder 13, by a sampling rate calculating section 14. The image-composing memory 12 is designed to compose and store a corrected line image data fed from the CCD line sensor camera 11. A data compression section 15 is designed to compress the data so as to store it in the hard disk HDD 16, and at the same time, controlling information is also stored in the hard disk HDD 16. A transmitting image data processing section 17 is designed to process the image data for transmission. A transmission packet assembling section 18 is designed to assemble the resultant image data into a transmission packet, which is then held by a packet buffer 19. The packet is subsequently delivered by a packet delivering circuit 20 and then subjected to a digital modulation at a digital modulation circuit 21 and to a frequency conversion for transmission at a transmission CH frequency conversion circuit 22. The resultant data is transmitted from a wave composing circuit 23 via a transmission line to the production controller 200.

A17

Please replace the paragraph beginning on page 20, line 13, with the following rewritten paragraph:

A18

In the system suspension processing (step S7), a determination is performed as to whether t2 = going-out time te (n) (the going-out-starting time tes (n) or the going-out-finishing time tee (n)) is abnormal (step S11) . If the result is NO and there is no abnormality, a determination is performed as to whether t3 = going-into time ti (n+1) (the going-into-starting time tis (n+1) or the going-into-finishing time tie (n+1)) is abnormal (step S12). If the result is NO and there is no abnormality, the operation returns to the step S11 so as to continue watching the occurrence of abnormality. On the other hand, if the result is YES in the step S11 or step S12 and there is any

abnormality in t2 or t3, the suspension of inspection is instructed to the sampling control section 10 and the occurrence of abnormality is transmitted to the production controller 200 (step S13). The result of the determination of abnormality is recorded in the flag register 7a. At this time, the timer (3) is started (step S14) and then, it is determined as to whether the inspection should be restarted (step S15). If the result is YES and the inspection is restarted, the operation returns to the step S11. On the other hand, if the result is NO and the inspection is not restarted, it is determined by means of the timer (3) as to whether a predetermined time has elapsed (step S16). If the result is NO and the predetermined time has not yet elapsed, the system forces the operation bring into a state of standby until the predetermined time has elapsed. If the result is YES and the predetermined time has elapsed, the system- suspending procedure is executed (step S17), thereby finishing the operation.

A18

Please replace the paragraph beginning on page 21, line 11, with the following rewritten paragraph:

FIG. 12 is a flow chart indicating the operation of the board identification section 4 (see FIG. 2) . First of all, it is determined if the photoelectric switch SW1 is ON (step S21). If the result is NO and the photoelectric switch SW1 is not ON, the board identification section 4 forces the operation to bring into a state of standby until the photoelectric switch SW1 is turned ON. If the result is YES and the photoelectric switch SW1 is ON, a going-into time t1 = ti (n) (the going-into-starting time tis (n) or the going-into-finishing time tie (n)) is determined and recorded (step S22) and the timer (1) is started (step S23). Then, it is determined as to whether a predetermined time corresponding to the time to the going-out has elapsed (step S24). If the result is NO and the predetermined time has not yet elapsed, the system forces the operation to bring into a state of standby until the predetermined time has elapsed. If the result is YES and the predetermined time has elapsed, it is determined as to whether the photoelectric switch SW2 is ON (step S25) . If the result is NO and the photoelectric switch SW2 is not ON, the board identification section 4 forces the operation to bring into a state of standby until the photoelectric switch SW2 is turned ON. If the result is YES and the photoelectric switch SW2 is ON, it is then determined whether the photoelectric switch SW2 is turned OFF (step S26). If the result is No and the photoelectric switch SW2 is not OFF, the board identification section 4 forces the operation to bring into a state of standby until the photoelectric switch SW2 is turned

A19

OFF. If the result is YES and the photoelectric switch SW2 is turned OFF, an going-out time t2 = te (n) is determined and recorded (step S27). Then, a determination is made as to whether this t2 can be assumed as being the scheduled going-out time (step S28). If the result is NO and this t2 cannot be assumed as being the scheduled going-out time, the operation is advanced to the system suspension (FIG. 11). If the result is YES and this t2 can be assumed as being the scheduled going-out time, the timer (2) is started (step S29). Next, it is determined as to whether the photoelectric switch SW3 is ON (step S30). If the result is NO and the photoelectric switch SW3 is not ON, the board identification section 4 forces the operation to bring into a state of standby until the photoelectric switch SW3 is turned ON. If the result is YES and the photoelectric switch SW3 is ON, the going-into time of the next process t3 = ti (n+1) is determined and recorded (step S31) . Then, a determination is made as to whether this t3 can be assumed as being the scheduled going-out time (step S32) . If the result is NO and this t3 cannot be assumed as being the scheduled going-out time, the system is advanced to the system suspension (FIG. 11). If the result is YES and this t3 can be assumed as being the scheduled going-out time, the operation returns to the step S21.

A19

Please replace the paragraph beginning on page 25, line 24, with the following rewritten paragraph:

FIG. 15 is a diagram illustrating an example of the construction of the transmission packet. This transmission packet is of fixed length and consists of the preamble (PA) PI, a process number P2, a process-going-into or entry time P3, a process-going-out or exit time P4, a board image data P5, an abnormality occurrence indication flag P6, and the delimiter P7.

A20

Please replace the paragraph beginning on page 26, line 1, with the following rewritten paragraph:

FIG. 16 is a diagram illustrating an entire sequence of each transmission packet. In this case, the packet is represented by "provisional board number-process number". The time axis A indicates the position of the packet in a specific manufacturing process in which the work board 1 is transferred with time. For example, as indicated by "1-3", "2-3" and "3-3" in the manufacturing process 3, the work board having provisional numbers 1, 2 and 3 goes into and goes out from the manufacturing process 3 with time. Whereas the time axis B indicates the position of the packet as a specific work board 1 is transferred through each manufacturing

A21

A21 process with time. For example, as indicated by "3-1", "3-2" and "3-3", the work board having a specific provisional number 3 enters and then exits each manufacturing process with time.

Please replace the paragraph beginning on page 28, line 25, with the following rewritten paragraph:

A22 As a result, changes in external appearance of the work board processed or treated at each manufacturing process can be compared relative to each other, so that it becomes possible to detect any non-uniformity in external appearance of the work board that might be occurred due to the same repeated working process even if there has been no problem in the transferring of the work board. Therefore, information which is useful is obtained for accelerating the stabilization of the manufacturing processes.

Please replace the paragraph beginning on page 29, line 4, with the following rewritten paragraph:

A23 Further, since a defective work board 1 is encircled by a frame, for instance, in the display thereof, the location of manufacturing process as well as the time at which the abnormality was generated can be immediately recognized. A window 86 will be displayed at the left bottom corner of the display to display a going-out time of the work board. Thus, moving a cursor to the diaplay porion of the work board 1, and clicking the mouse botton enables display of the exit time.

Please replace the paragraph beginning on page 29, line 23, with the following rewritten paragraph:

A24 FIGS. 20 A, B, and C are flow charts indicating the operation of the production controller 200. First of all, a determination is made as to whether the system power source is ON (step S81). If the result is NO, the system forces the operation to bring into a state of standby until the power is turned ON. If the result is YES, the initialization of the system is performed (step S82).

Please replace the paragraph beginning on page 31, line 26, with the following rewritten paragraph:

A25 Further, according to the present invention, it is possible to distinguish an individual work board which is inherently difficult to distinguish from the others by the external appearance thereof, so that it is possible to accurately grasp the progress of working, i.e. the position of